Terrestrial Isopods (Oniscidea) in a Secondary Successional Row on Abandoned Fields

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Introduction

Terrestrial isopods are characteristic of undisturbed habitats (e.g. Sutton 1972, Davis and Sutton 1978) above all of natural woodland and grassland habitats. In areas disturbed by human activities including arable lands they are often rare or nearly missing. Secondary succession of these soil invertebrates has been studied on afforestated spoil banks and reclaimed dumps of the brown coal mining regions (Neumann 1971, Dunger 1968), suburban fallow areas (Strueve-Kusenberg 1981, 1982) and refuse tips (Koscielny 1983). Some data are known about their presence on reclaimed cutaway peat (Curry and Momen 1988). Paoletti (1983) noted that tillage practices in agroecosystems interact severely on isopods and presence of litter, and stable vegetation on the top soil seems to improve their density and diversity. The present contribution deals with the community structure and activity of terrestrial isopods in a secondary successional row on the abandoned fields. The study was realised as a part of complex research project undertaken by the Institute of Soil Biology, Czechoslovak Academy of Sciences.

Study sites and methods

Five stages of a secondary successional row, situated in South Bohemia near Chelcice (stages 1—4, 49°06'N, 14°07'E, 560 m a.s.l.) and Malovice-Hradiste villages (stage 5, 49°04'N, 14°09'E, 480 m a.s.l.), were studied during the years 1986-1991: stage 1 — field: initial stage permanently in crop rotation (1986 wheat, 1987 potatoes, 1988 barley, 1989 and 1990 mixture of oats, peas and clover); stage 2 — fallow: abandoned field, from autumn 1985 without crop rotation with significant successive development of vegetation from 1986 (plant association *Apera spica-venti*, alliance *Aphanion*); stage 3 — meadow: last ploughing and agricultural interferences in 1975-1977 and then up to 1985 regularly mown, present plant community *Agropyron repens—Holcus mollis* (alliance *Arrhenatherion*); stage 4 — unmown meadow: fallow of the same age as stage 3 but never mown and covered with plant community *Holcus mollis—Hypericum perforatum*; stage 5 — forest: 60-70 years old mixed acidophilous oak wood with several limes, beeches, maples and spruces, plant community *Abieto-Quercetum* (alliance *Genisto germanicae—Quercion*) as a subclimax of this region.

Table 1. Mean density of terrestrial isopods (ind. m^{-2}±SE) on separate stages of secondary successional row

	field	fallow	meadow	forest
1986	0	0	0	31.1±17.0
1987	0	0.7±0.7	0	12.8±11.1
1988	0	1.9±1.1	0.5±0.5	24.7±6.0
1989	0	5.9±1.5	4.8±2.1	25.6±7.7
1990	0.9±0.9	14.6±7.9	12.8±10.7	71.2±33.3
1986-1990	0.2±0.2	4.6±2.4	3.6±2.7	33.1±15.0

The examined area is characterised by brown soil type (entric cambisol), stages 1 and 2 with a plough humus horizon, stages 3 and 4 with mull humus horizon and stage 5 with mull-moder humus horizon. Yearly mean air temperature is 7.3°C, precipitations per year 650 mm.

The soil samples (5 from each stage, area 1/16 m^2, depth 10 cm) were taken monthly as from May 1986 on the stages 1 and 2 till May 1990, on the stages 3 and 5 till May 1988 and then on all these stages in 3 months intervals untill May 1991. Soil samples were hand sorted and then heat extracted by modified Kempson extraction apparatus (Kempson *et al.* 1963). Pitfall traps (each with catching area 36 cm^2 and formalin killing-preserving solution), emptied every two weeks from April 1986 till April 1988, were situated on the stages 2, 3, 4 and 5 ten in number. On the stage 1 there was no trap on account of frequent agrotechnical interference.

Results

The mean annual densities of terrestrial isopods on separate plots are given in Table 1. Very low density was noted in the field (stage 1). In the fallow and meadow they did not reach high values, too (4.6 ind. m^{-2} and 3.6 ind. m^{-2} respectively). The highest density was established in the forest (33.1 ind. m^{-2}). During the five years the mean annual densities gradually increased from zero values in the first year of

Table 2. Total numbers of terrestrial isopods from pitfall traps on separate stages of secondary successional row

	field	fallow	meadow	unmown meadow	forest
1986	—	2	3	463	752
1987	—	0	2	605	857
1986-1987	—	2	5	1068	1609

Table 3. Species composition, % of individuals obtained by both methods on separate stages of secondary successional row

	field	fallow	meadow	unmown meadow	forest
L. hypnorum	—	—	78.0	—	0.2
L. minutus	—	—	—	0.1	—
P. politus	100	97.1	19.5	99.4	99.2
T. ratzeburgi	—	2.9	2.5	0.4	0.6
A. opacum	—	—	—	0.1	—

the fallow succession as well as in the meadow after interruption of mowing up to 14.6 ind. m^{-2} and 12.8 ind. m^{-2}, respectively. In the forest the annual density of isopods decreased in the second year from 31.1 ind. m^{-2} to 12.8 ind. m^{-2} and then gradually increased up to 71.2 ind. m^{-2} in 1990.

Results of soil surface activity of terrestrial isopods established by pitfall trapping in two first years of investigation separated the stages 4 and 5 from precedent stages of successional row (Table 2). The high numbers of caught animals in the unmown meadow put this stage in successional row more to the forest stage than to the younger open stages.

In all, the presence of 5 species of terrestrial isopods was established by both methods in the studied successional row (Table 3). *Protracheoniscus politus* (C. L. Koch, 1841) took the highest density and activity in the isopod communities of four successional stages. *Trachelipus ratzeburgi* (Brandt, 1833), characteristic namely in spruce forests in the region under study, penetrated in low density almost into all investigated plots. The presence of *Ligidium hypnorum* (Cuvier, 1972) in high portion in the meadow (stage 3) seems to be connected with the enhancement of groundwater level and higher humidity on a part of this plot probably after interruption of mowing. *Lepidoniscus minutus* (C. L. Koch, 1838) and *Armadillidium opacum* C. L. Koch, 1841 were noted on the stage 4 only.

Figure 1 shows the dynamics of density (full lines) and epigeic activity (columns). While in the field the isopods were noted only in one sampling time, in fallow they were present in pitfall traps as early as in the first years of succession and their density gradually increased. From the fourth year of the succession more or less the continual presence of this community was noted here. In the first two years pitfal traps showed the presence of *L. hypnorum* and *P. politus* in the meadow, but the first data about density of isopods were obtained only in the third and Subsequent years here. The density of isopods in meadow newer reach that in fallow (Table 1). Unmown meadow, where the community of isopods was studied only by trapping, was characterized by high epigeic activity. In the contradiction to epigeic activity in forest, it was lower, with maxima in September. The forest maxima of epigeic activity fell into July or June, they took place in the summer depression of population density (esp. 1986). Density dynamics in the forest was during the whole five years more or less irregular. Newertheless, for the last three

years (1988-1990) they were characteristic the minima in May and the August or November.

Discussion

The studies of secondary succession on different fallow lands, reclaimed dumps etc. showed, that the development of the terrestrial isopod communities is influenced by many factors. Depending on the age and the distance of afforestations from the wood the number of species and individuals of isopods increased successively from spoil banks to the oldest afforestations (Neumann 1971). Strueve-

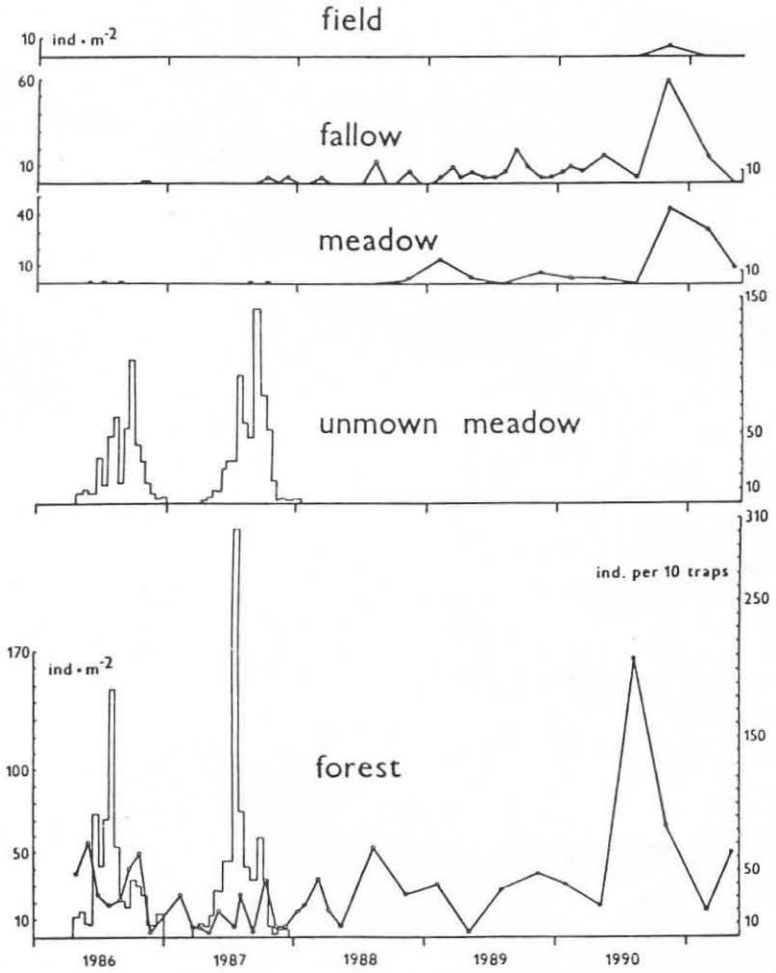

Fig. 1. Density dynamics (full lines, ind. m^{-2}) and epigeic activity (columns, numbers of individuals in 10 traps) on separate stages of secondary successional row

Kusenberg (1981, 1982) noted that the island like character of the fallow land enabled the colonization by isopods, millipedes and earthworms to begin, and due to the rapid development of the vegetation, the young fallow areas were rapidly colonized by terrestrial isopods, too. Nevertheless, the higher numbers of these invertebrates were obtained in 10 years and older fallows. The results of our study confirmed that although the first individuals were capable to penetrate into just abandoned field, only the later, stabilized stages of succession with developed vegetation cover were characterized by relatively dense populations of isopods. Arable land was nearly without these invertebrates (e.g. Paoletti 1987). The isopod community formed slowly in the end of the second and in the third years of fallow development when the vegetation was present here. The differences between the meadow and unmown meadow (stages 3 and 4, respectively) are given probably by previous different management practices. Unmown meadow with thicker layer of grass litter seems to be a more suitable environment for the development of isopod community. As the most abundant species of the region under study, *P. politus* was the commonest both in the initial as well as the older stages of the successional row. Due to the more humid character of the meadow (stage 3), in the contradiction to the other studied stages, the higher presence of *L. hypnorum* was noted here.

The recolonization of abandoned fields by terrestrial isopods takes place more slowly them by other soil arthropods (Neumann 1971, Dunger 1968) which is connected namely with a well developed vegetation, consequently with enough of shelters as well as food resources for these soil saprophagous invertebrates.

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